

What is claimed is:

- 1 1. A method for forming a wafer of a compliant composite substrate, comprising the steps
- 2 of:
- 3 a) selecting a first substrate material having a melting point of T_{m1} ;
- 4 b) selecting a second substrate material having a melting point of T_{m2} ;
- 5 c) selecting a joint metal with a melting point of T_m ; wherein
- 6 i) said joint metal and said first substrate material form a first eutectic
- 7 alloy at a first eutectic temperature T_{eu1} while said joint metal
- 8 and said second substrate material form a second eutectic
- 9 alloy at a second eutectic temperature T_{eu2} ; and
- 10 ii) T_{m1} and $T_{m2} > T_m > T_{eu1}$ and T_{eu2} ;
- 11 d) depositing said joint metal on a side of said first substrate material to
- 12 form a first intermediate substrate;
- 13 e) depositing said joint metal on a side of said second substrate material to
- 14 form a second intermediate substrate;
- 15 f) forming a substrate pair by combining said first and second intermediate
- 16 substrates such that said sides of said first substrate material and
- 17 said second substrate material having said joint metal on them are
- 18 against each other;
- 19 g) ramping a temperature of said substrate pair up to at least T_m , whereby
- 20 said temperature passes through T_{eu1} and T_{eu2} ; and
- 21 h) cooling, after step (g), said substrate pair to form said compliant
- 22 composite substrate.

2. A method according to claim 1, further comprising enhancing adhesion between said first and second intermediate substrates by preliminarily bonding said substrate pair.

3. A method according to claim 1, wherein the steps of ramping and cooling are conducted in a high vacuum.

4. A method according to claim 1, further comprising soaking said substrate pair, after step (g) and before step (h), for a specified period of time.

5. A method according to claim 1, further comprising forming a protective layer, before step (d), on said second substrate material on which epitaxial layers are to be grown.

6. A method according to claim 1, wherein said first substrate material is Ge and said second substrate material is Si.

7. A method according to claim 6, wherein said joint metal is Al + 1% Si.

8. A method according to claim 1; further comprising selecting a first thickness of said joint metal deposited in step (d) and a second thickness of said joint metal deposited in step (e) such that a total thickness (t) of said joint metal is the sum of said first thickness and said second thickness, and said total thickness (t) satisfies an equation $t \geq D \Delta\alpha / \alpha \times 10^{-4}$, where D is a dimension of said wafer, and $\Delta\alpha / \alpha$ is a ratio of a thermal mismatch between Sub1 and Sub2 which equals $|(\alpha_1 - \alpha_2)| / 1/2 (\alpha_1 + \alpha_2)$.

9. A method according to claim 8, further comprising selecting α_{eff} such that α_{eff} is approximately equal to a thermal expansion coefficient of an epitaxial layer to be grown on said composite substrate.

10. A method according to claim 1, further comprising selecting a first thickness of said first substrate material and a second thickness of said second substrate material such that:

$$\alpha_{\text{eff}} = (\alpha_1 t_1 + \alpha_2 t_2) / (t_1 + t_2)$$

where α_{eff} is a thermal expansion coefficient of said composite substrate, α_1 is a thermal expansion coefficient of said first substrate material, α_2 is a thermal expansion coefficient of said second substrate material, t_1 is said first thickness of said first substrate material, and t_2 is said second thickness of said second substrate material.

11. A method according to claim 10, further comprising selecting α_{eff} such that α_{eff} is approximately equal to a thermal expansion coefficient of an epitaxial layer to be grown on said composite substrate.

12. A method according to claim 1, further comprising selecting said first substrate material and said second substrate material such that:

$$\alpha_{\text{eff}} = (\alpha_1 t_1 + \alpha_2 t_2) / (t_1 + t_2)$$

where α_{eff} is a thermal expansion coefficient of said composite substrate, α_1 is a thermal expansion coefficient of said first substrate material, α_2 is a thermal expansion coefficient of said second substrate material, t_1 is said first thickness of said first substrate material, and t_2 is said second thickness of said second substrate material.

13. A method according to claim 12, further comprising selecting α_{eff} such that α_{eff} is approximately equal to a thermal expansion coefficient of an epitaxial layer to be grown on said composite substrate.

14. A compliant composite substrate formed by the method of claim 1.

15. A compliant composite substrate formed by the method of claim 8.

16. A compliant composite substrate formed by the method of claim 10.

17. A compliant composite substrate formed by the method of claim 12.